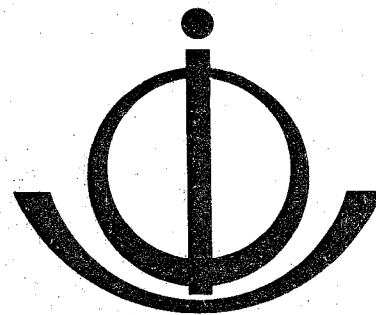


INTERNATIONAL TSUNAMI INFORMATION CENTER



INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
COMMISSION OCEANOGRAPHIQUE INTERGOUVERNEMENTALE
COMISION OCEANOGRAFICA INTERGUBERNAMENTAL
МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ

P. O. Box 3650, Honolulu, Hawaii 96811 USA

NEWSLETTER

Volume IX, Number 3
September 1976

The ITIC Newsletter brings news and information to tsunami researchers, engineers, educators, community protection agencies and governments in 36 countries. We welcome your news, reports, papers, or abstracts.

Severe Earthquake and Tsunami Hit the Philippines, August 16, 1976

Mindanao, the southernmost and largest of the Philippine Islands, was rocked by an earthquake of magnitude 8.0 on the Richter scale, during the early morning hours of August 17, local time (1610 UTC Aug. 16). This earthquake generated a devastating tsunami in the Celebes Sea that caused havoc and destruction along coastal communities of the Moro Gulf in Mindanao and neighboring Sulu Islands. More than 8,000 people were killed or are missing, making this the worst earthquake and tsunami disaster in the history of the Philippines.

- - - - BULLETIN: DIRECTOR AND ASSOCIATE DIRECTOR, ITIC, SURVEY TSUNAMI DAMAGE IN THE PHILIPPINES, TURN TO PAGES 3 - 6 FOR DETAILS - - - -

Early reports estimated the earthquake epicenter to be somewhere in the Celebes Sea between the islands of Mindanao and Borneo. These reports listed that thousands of persons were either killed or missing and that many more were made homeless by the earthquake and subsequent tsunami waves. The earthquake occurred at night, when offices and schools in Cotabato, Zamboanga, and other cities were unoccupied and this reduced loss of life in the major centers. However, in the coastal fishing communities where most of the houses are built on posts on tidal beaches and even in bays, the tsunami waves swept through the villages in near darkness, only minutes after the people had been roused by the tremor. No tradition existed to move to higher ground in the event of a severe earthquake and people were caught and washed out to sea.

Damage to boats and fishing gear was heavy and the livelihood and the economy of many coastal communities have been disrupted. Relief operations began almost immediately by local civil and military agencies, and the government of the Philippines acted promptly to begin rehabilitation and reconstruction.

Honolulu Observatory posted a tsunami watch following the earthquake and queried tide stations of the Tsunami Warning System in Okinawa, Yap, and Malakal. Based on

negative wave reports from these stations, Honolulu Observatory determined there would be no Pacific-wide tsunami and cancelled the watch. Apparently, most of the tsunami energy was trapped in the Celebes Sea which is bounded by numerous islands and shoals.

According to reports received from the Indonesian Hydrographic Office, no unusual wave activity affected the Sulawesi (Celebes) and Kalimantan (Borneo) Coasts of Indonesia.

Major Earthquakes in China

The world's largest earthquake in the last twelve years took place in Hopeh Province, China, during the early morning hours of July 28, 1976 (1943 UTC July 27). The quake severely hit the cities of Peking, Tientsin, and Tangshan, which have a combined population of about 15 million. Initial reports stated that extremely serious damages occurred in the city of Tangshan. This earthquake of magnitude 8.0 has only been surpassed recently by the devastating earthquake that shook Alaska on March 28, 1964. The Alaska quake had a magnitude of 8.6.

Within 15 hours after the first earthquake, a second earthquake of magnitude 7.0 struck the same heavily populated area. The epicenter of this major aftershock was located approximately 30 kilometers northeast of the first earthquake's epicenter.

Director, Manila Observatory Arrives at ITIC for 6-week Working Visit

Dr. (The Reverend Father) Victor L. Badillo arrived in Honolulu on August 16, for a 6-week working visit at ITIC under the UNESCO-Intergovernmental Oceanographic Commission's Visiting Scientist Program. Dr. Badillo is director of the Manila Observatory, in the Philippines. The Manila Observatory, located in the Loyola Heights section of Quezon City, Philippines, is a multidisciplinary facility.

According to Dr. Badillo, "Work at the Manila Observatory is focussed on two areas: seismology and sun-earth relationships. (Emphasis was put on these two because of their special interest to the Philippines, but by coincidence there is a revived interest in them world-wide). The Philippines is in a region that is very active seismically, lying as it does on the boundary of moving tectonic plates. Over the years the country has suffered much and often from earthquakes, and recently from a tsunami too. There is need to delineate earthquake risk zones and tsunami inundation areas. The Manila Observatory maintains three seismic stations: Baguio in the north, Davao in the south and Manila in between." (Editor's Note: Badillo departed Honolulu on September 19, after a very productive visit to ITIC).

Visiting Japanese Seismologist Arrives at ITIC

Mr. Masahiro Kishio, Seismological Division, Japan Meteorological Agency, arrived in Honolulu on October 4, for a 6-week working visit at ITIC. We will have further details on Mr. Kishio's visit to ITIC in our December Newsletter.

NEWS EVENTS

Numerous Earthquakes Affect Pacific Area

During the last 3 months, there have been many strong earthquakes in and around the Pacific with events such as the magnitude 8.0 earthquake that struck northeast China on July 27, and the magnitude 7.8 earthquake and tsunami in the Philippines, on August 16.

The Ryukyu Islands, south of Japan, were hit by a moderate earthquake of magnitude 6.0 on June 20, 1976, at 0438 UTC. Tokyo's JMA issued an emergency local tsunami warning for this earthquake but cancelled it within an hour. ITIC is awaiting information on any local tsunami action caused by this earthquake.

Later, on June 20, at 2053 UTC, a strong earthquake occurred to the southwest of Sumatra, Indonesia. ITIC has queried the Indonesian government regarding any local tsunami generated by this earthquake and is presently awaiting a response.

On June 25, 1976, a strong earthquake hit West Irian, Indonesia, causing numerous landslides in the mountainous areas. Later reports indicated there were up to 5,000 deaths resulting from the earthquake and subsequent landslides. The location of the earthquake was such that a Pacific wide tsunami would not be generated. As a precautionary measure, Honolulu Observatory queried tide stations in the vicinity to monitor any unusual tidal disturbances. All stations queried reported no unusual disturbances.

On July 17, 1976, a magnitude 6.5 earthquake took place in the Bismarck Sea, near the Solomon Islands. Honolulu Observatory determined that the magnitude of this earthquake was not sufficient to generate a Pacific wide tsunami. A magnitude 6.7 earthquake earlier this year in May took place near the July 17, epicenter.

The first major earthquake in August occurred in the vicinity of the New Hebrides Islands. This magnitude 6.9 earthquake was not sufficiently large to generate a Pacific wide tsunami. According to official reports from Noumea, New Caledonia, there were no casualties or material damage resulting from the earthquake.

(The major earthquakes in China and the Philippines, occurring on July 28 and August 16, respectively, are covered in the feature article section of this Newsletter.)

A major aftershock of the August 16, earthquake in the Philippines occurred on August 17, and registered 6.8 on the Richter scale. According to the Philippine Red Cross, at least fifteen aftershocks were felt in Cotabato City prior to this major aftershock. The area continues to be effected by smaller aftershocks as a major clean up and rehabilitation effort is being undertaken by the Philippine government.

No major earthquakes occurred in the Pacific during the month of September.

ITIC-PAGASA-USGS Survey of the Earthquake and Tsunami of 16 August 1976 in the Philippines

On August 17, 1976, a devastating earthquake of approximate magnitude 8 on the Richter Scale hit the island of Mindanao in the Southern Philippine Islands. The epicenter of

this earthquake was in the Gulf of Moro in the Celebes Sea. A large tsunami generated by the earthquake resulted in the death of thousands of people in coastal communities in the Sulu Islands, and North and South Zamboanga, North and South Lanao, North Cotabato, Maguindanao, and Sultan Kudarat, on the island of Mindanao. In response to this tsunami disaster, and in accordance with the role of ITIC in obtaining information and documentation of major catastrophic tsunamis, George Pararas-Carayannis and Sydney Wigen proceeded to the Philippine Islands a few days later to conduct a tsunami survey.

In Manila, the Administrator of PAGASA, Dr. Roman L. Kintanar and other officers of PAGASA, and Commodore Jayme Presbitero, Director of the Coast and Geodetic Survey, and members of his staff were contacted. A tentative plan for a survey of the stricken area was drawn and with support from these two agencies. For maximum coverage of the extensive survey area the ITIC team split, George Pararas-Carayannis proceeded to Mindanao accompanied by Mr. Antonio Sucre, an engineer of PAGASA. Syd Wigen proceeded to the Sulu islands.

In Zamboanga City, Mindanao, the ITIC-PAGASA team was joined by Mr. Rolando C. Valenzuela, Supervising Seismologist of PAGASA and an assistant. The objective of the survey was to obtain measurements of wave heights reached by the tsunami along the coast of Mindanao, measurements of the horizontal extent of inundation, and estimates of time intervals between the earthquake and the arrival of the waves. Accurate information about the exact limits of tsunami inundation is of important scientific value in understanding tsunamis generally. There is also great economic importance in estimating the danger to existing or proposed structures in the areas of inundation, both for the protection of property and people. It was hoped that a detailed survey of the stricken area would give a better understanding of the tectonic history and orientation of major faults in the area, which is information of great significance to the Tsunami Warning System in the assessment of future tsunamis for this region.

After a preliminary survey of the coastal area in the vicinity of Zamboanga City, the survey party flew to Pagadian City in the state of South Zamboanga. On the second day in Pagadian City, the ITIC-PAGASA team was joined by Dr. Robert Wallace of the U.S. Geological Survey. Pagadian City is the major city in the area that was struck by both the earthquake and tsunami and reported the greatest number of casualties. A survey of Pagadian City and of the vicinity was undertaken. This survey included measurements of the horizontal and vertical extent of inundation, observations on the failure of structures and buildings, collection of information on the seismic affects, interviews of eyewitnesses and officials, and observations on the response of the people to the disaster. In addition, statistical information was gathered on loss of life and property. The Governor of South Zamboanga, Mr. Tecson, and the military commander in the area provided logistical support for the survey. Two helicopters and a number of soldiers were made available. The survey was not as extensive as it could have been. However, it was sufficient to provide a fairly good understanding of the distribution of wave heights and effects of the earthquake along the coastal areas of this part of Mindanao.

In addition to ground measurements, an aerial photographic survey of the tsunami runup areas was undertaken, flying at low altitude along the coast. Some of the areas that were hardest hit by the earthquake and tsunami were either visited or surveyed from the air. These included the villages of Margosatubig, Malangas, Alicia, Tabina, San Pablo, Labangan and Tukuran. In the following two days, with support of the military command at Cotabato City, the survey was extended along



Collapsed Bridge at Cotabato City, Philippines from the earthquake of 16 August 1976. (Photo Courtesy, Philippine Government)

Dr. George Pararas-Carayannis (left) ITIC, and Dr. Robert Wallace (right) of the U. S. Geological Survey, preparing to board helicopters to survey earthquake and tsunami damage in the Zamboanga area of Mindanao in the Philippines.



the north and eastern part of the Llana Bay, including the area of Karomatan, Malabang and Cotabato City, Bongo Island, Linek, Kinimi, Resa Bay, Port Lebak. Port Lebak was the southernmost point along the eastern part of the Moro Gulf that was visited. No casualties were reported from the state of South Cotabato, other than a seiche in Lake Sebu, an inland lake, which according to reports destroyed 200 homes. Since no death reports were given for this part of southern Mindanao, it was assumed that the waves in this area were insignificant, and because of time limitations a survey of this area was not undertaken.

Following the investigation of the eastern part of Moro Gulf, the survey party returned to Zamboanga City to begin inspection of the western side of the Gulf of Moro. Aircraft for this leg of the survey were made available by the military command in Zamboanga City. Both these islands experienced large waves and many deaths from the tsunami were reported. On the island of Basilan, for example, 14 foot waves were reported, killing about 36 people. On the island of Jolo, the death toll was 89, with 107 missing. Unable to proceed in this area, at that time, the survey was continued along the eastern portion of north of Zamboanga City, and the offshore islands in the Moro Gulf. The survey of this coastline was extended as far north as Bolon and in the offshore islands of Sacol, Malanipa, and Tictauan.

Based on the survey of the affected area, it was concluded that maximum waves in the entire Moro Gulf area were in the order of 14-15 feet, which were considerably less than what had been reported in the newspapers. Such large waves were experienced at Alicia, Pagadian City, Bongo Island, Resa Bay, Lebak, and the east coasts of Basilan and Jolo islands. Based on the distribution of wave heights along the coastline of Moro Gulf, estimates of travel times of the tsunami to each point, and the directional failure of structures, both by the earthquake and the tsunami, it was concluded that the earthquake and the tsunami generating area was in the upper part of Moro Gulf, somewhat south of Baganian Peninsula and that the fault line was primarily under water in the Moro Gulf having an orientation from southeast to northwest. This conclusion is supported by ground deformations and building failures at both Tabina and Cotabato City and earthquake intensities that were reported. Surprisingly, the earthquake, although of great magnitude, produced little ground deformation on land areas. The majority of buildings failed because of poor construction or inadequate foundations. A number of buildings that failed were sitting on alluvial deposits with no pile support. Evidence of ground liquefaction was found in many areas where mud bubbles had reached the surface. Ninety percent of all deaths were the result of the tsunami. Hardest hit were Moslem Communities where a number of residences are either close to the coastline or on stilts in the water. The great number of deaths in these communities is attributed to lack of awareness of the potential danger of earthquakes and tsunamis. Although in some areas, a 5 to 15 minute interval passed before the arrival of the tsunami, the victims in the area did not seek higher ground following the earthquake, but remained in their homes.

In conclusion, it is believed that the joint ITIC-PAGASA-USGS Survey was particularly beneficial to the scientific agencies in the Philippines in planning for a program of civil preparedness, related to the potential tsunami hazard from local earthquakes. Furthermore, the survey was of great benefit to the Tsunami Warning System in the Pacific because useful information was documented which can serve as a basis for the assessment of potential tsunamis for this area of the Pacific.

REPORTS FROM INTERNATIONAL TSUNAMI INFORMATION CENTER - HONOLULU

Systematic Collection of Tsunami Data

The International Tsunami Information Center continues to solicit tide records and other related information in support of its ongoing program for the systematic collection of tsunami data. Since the publication of our last Newsletter, ITIC has queried gauging authorities in various countries for the following earthquakes; 0601Z May 23, 1644Z Jun 3, 0737Z Jun 7, 1427Z Jun 7, 0438Z Jun 20, 2053Z Jun 20, 1919Z Jun 25, 1031Z Jun 26, 1943Z Jul 27, and 0420Z Aug 17. ITIC will appreciate receiving replies from those authorities that have been queried and expresses appreciation to those that have so promptly responded.

ITIC would appreciate receiving tidal records or tsunami accounts even if a specific request for tsunami information has not been formally submitted.

Editorials and Letters

The Director and staff of ITIC would like to have this Newsletter provide a broader communication service in the world tsunami community. We are prepared to provide one or two pages per issue for editorial comment and Letters to the Editor, and we invite each of you as a reader to submit your thoughts for consideration and possible publication.

Comments may relate to any aspects of tsunamis, tsunami service, or to the Newsletter itself.

Editorial Section

Both myself and the Associate Director of ITIC would like to acknowledge with appreciation the support provided to us by Government agencies and individuals in the Philippines during our recent survey of the coastal areas of Mindanao and Sulu islands affected by the earthquake and tsunami of 17 August 1976. In particular, we would like to express our appreciation to the Executive Office, the Administrator of PAGASA, Dr. Roman L. Kintanar and his staff, Director of the Coast & Geodetic Survey, Commodore Jayme Presbitero and his staff, the Governor of Zamboanga Del Sur, Mr. Jose Tecson, the military commanders at Pagadian, Cotabato and Zamboanga Cities, and the Governor and the military commander at Basilan Island.

Because of their support we were able to assess better the effects of the 17 August 1976 earthquake and tsunami in Mindanao, and to document useful information of great significance to the Tsunami Warning System in assessing tsunami potential of this region.

We appreciate also the warm co-operation of the people of so many coastal communities, who in a time of great personal loss were still prepared to answer our many questions about their experiences relative to the earthquake and tsunami.

George Pararas-Carayannis
Director, ITIC

Coral Sea Volcano Erupts

ITIC received reports on Friday, August 27, 1976, that a volcanic eruption was taking place in the Coral Sea between Australia and New Caledonia. Reports from a vessel transiting the area indicated that the volcano disturbed the seas within a two mile radius and was ejecting lava up to 200 feet in the air.

The location of the eruption was given as 18° 79' north - 157° 59' east, and it does not endanger any inhabited area. There was some unusual wave action generated in the area. It was expected that this unusual condition would not generate any Pacific-wide disturbance, but would be confined to the immediate area.

Deep Sea Wave Energy Study

The Joint Tsunami Research Effort in Honolulu reports that a recent experiment has been completed near the equator which should provide information on the mid-ocean tsunami background spectrum. Energy as a function of direction and frequency will be computed from the pressure records obtained at the sea floor from an array of four instruments which were recovered of the eight units which were deployed. In addition to the bottom pressure units which record long waves, four deep ocean recording current meters were also recovered. Two of the pressure recording instruments should have the capability of measuring any waves which might have propagated across the Pacific as a result of the Philippine earthquake which occurred on August 16, 1976. Dr. Gaylord Miller of JTRE reports that these instruments can record pressure fluctuations corresponding to a change in hydrostatic pressure of less than a millimeter of water level. A report on these results will be available for the next ITIC Newsletter.

Mr. Sydney Wigen Receives One-Year Extension as Associate Director, ITIC

It has been formally announced that Mr. Sydney Wigen has accepted an extension of one year as Associate Director, ITIC. Mr. Wigen will be serving in this capacity until August 31, 1977, at which time a new, and not yet announced, Associate Director will assume responsibilities.

Mr. Wigen, Regional Tidal Superintendent of the Pacific and Western Arctic regions of the Canadian Hydrographic Service, will return to his duties in Canada upon completion of his assignment at ITIC.

TSUNAMI WARNING SYSTEM IN THE PACIFIC

Attu, Alaska, Tsunami Tide Station Destroyed

NOAA's National Ocean Survey has informed ITIC that the tide and tsunami station at Attu, Alaska, was recently destroyed due to the effects of heavy weather and age. The Pacific Tide Party mentioned that they do not plan to replace this installation. The present regional tsunami warning system in Alaska will still provide adequate tide information should a tsunami occur in the area.

Marcus Island (Minamitorishima) Tide Station Reinstalled

A tide gauge has been installed on Marcus Island in support of the University of Hawaii NORPAX Program and as a tsunami warning gauge for the Pacific Tsunami Warning System.

Various tide gauges have previously operated on the island, which is now occupied by contingents from the U. S. Coast Guard and the Japan Meteorological Agency. The U.S. National Ocean Survey operated a bubbler type tide gauge from 1964 through 1973 and the U.S. Atomic Energy Commission, now known as the Energy Research and Development Administration, operated a sophisticated micro tsunami gauge through the spring of 1976. The present gauge is a bubbler type similar to the one previously operated by the National Ocean Survey.

The U.S. Coast Guard has assumed the responsibility of monitoring the tide gauge in the event of a tsunami watch or warning and will relay wave information onto Honolulu Observatory. Mr. Ted Murphy of the University of Hawaii and Lt. Dennis Sigrist, Assistant Tsunami Specialist, National Weather Service, installed the present gauge in September.

Chief, National Ocean Survey's Pacific Tide Party Visits National Weather Service, Honolulu

NWS-Pacific Region Headquarters was visited from October 12-15 by Lt Richard Moore, Chief of the Pacific Tide Party. He obtained assistance from the NWS-Facilities-Engineering staff for rebuilding the Guam tide station, and is en route to return the Truk and Guam tide stations to service. The Guam and Truk tide stations are also part of the Pacific Tsunami Warning System.

NATIONAL AND AREA REPORTS

Minor Tsunami Recorded at Lord Howe Island, Australia

The Kermadec Island earthquakes of January 14, 1976, as reported in our March 1976 Newsletter, generated a small tsunami which was recorded at Lord Howe Island (31° 31'S, 159°04'E). This tsunami was also recorded at tide gauges located in Suva, Fiji; Apia, Western Samoa; and Pago Pago, American Samoa, as reported earlier.

The tide gauge at Lord Howe is located in a lagoon on the southwest side of the island. Initial arrival time of the tsunami was 2030Z, January 14. Maximum wave amplitudes of about one foot occurred thereafter.

We wish to express our appreciation to Australia's Division of Fisheries and Oceanography for providing us with this information.

Tsunami Recorded in the Gulf of Honduras, Caribbean Sea

The disastrous Guatemalan earthquake of February 4, 1976, as reported in our March Newsletter, generated a small tsunami that was recorded at the Puerto Cortez tidal

station located on the northeast coast of Honduras. The maximum crest to trough amplitude recorded at this station was 0.7 feet, or 24 centimeters. The arrival of the first wave occurred at approximately 0912Z indicating a travel time of only 10 minutes. ITIC is awaiting reports from other tidal stations regarding any unusual disturbances generated by this event.

Kuril Trench Earthquake and Tsunami, January 21, 1976

This strong earthquake of magnitude 7.3, as reported in the March 1976 ITIC Newsletter, generated a minor tsunami, according to a report submitted by Dr. S. L. Soloviev of the Sakhalin Scientific Complex, USSR. Dr. Soloviev kindly provided ITIC with the following information: "The above earthquake occurred at 10-hr 05-min 21-sec GMT, east of the Iturup Island at a point with the coordinates: Latitude 44.6° N, Longitude 149.2° E. Its magnitude was $M = 7.0$ to 7.3. It was felt in the town of Kurilsk with intensity force up to 5 (on 12-degree scale) and it was followed by weak tsunami waves.

The tide gauge in the settlement of Burevestnik recorded the first wave with an amplitude of +13 cm at 10-hr 40-min. The tide gauge recorded oscillations for 5 to 6 hours. The tsunami wave period was about 10 min.

The tide gauge in the settlement of Malokurilsk recorded the first wave at 11-hr 55-min. The amplitude of the wave was 12 cm. Its period was about 15 min. The oscillations were observed for 4 hours.

The Yuzhno-Kurilsk tide gauge recorded weakly readable arrival corresponding to a wave amplitude of +3 to 4 cm at 11-hr 55-min."

The Japan Meteorological Agency (JMA) has informed ITIC that they have checked their tide records from the Hokkaido region for this earthquake and noted no unusual disturbances.

Esmeraldas, Ecuador Earthquake, April 9, 1976

The strong earthquake that hit Esmeraldas, Ecuador earlier this year, apparently did not generate a local tsunami. Mr. Brent Ingre, Technical Director of Ecuador's Observatorio Astronomico, has kindly brought this information to the attention of ITIC. Mr. Ingre also stated that the earthquake's epicenter was situated 120 km (or more) northwest of Esmeraldas in the sea. ITIC reported the event's epicenter incorrectly as 120 km east of Esmeraldas.

Ryukyu Island Region Earthquake of June 20, 1976

According to reports received at ITIC from the Japan Meteorological Agency, no unusual disturbances were caused by the earthquake of June 20, 1976, in the Ryukyu Island region of Japan. JMA reported the epicenter was located at 24°31' North and 126°14' East. Additionally, the earthquake's magnitude was 6.2 on the Richter scale at a depth of 30 kilometers.

Information Exchanged on Possible Commercial Radio Transmission of Earthquake Warnings

A brief United States Geological Survey/United States National Weather Service information exchange took place at the USGS in Reston, Virginia, Friday, July 16, 1976. Joe Conte of the National Weather Service, Office of Meteorology and Oceanography Planning and Requirements Staff, met with Dr. Robert Hamilton, Chief of the Earthquake Studies, USGS. The purpose of the visit was to give the USGS information related to use of the Emergency Broadcast System for dissemination of warnings. The Emergency Broadcast System (EBS) is an association of commercial broadcast stations in the United States that can simultaneously transmit on local radio and television stations warnings or civil preparedness information. In turn, the USGS provided state-of-the-art earthquake prediction information. Hamilton says, "Much remains to be accomplished before earthquake prediction becomes as useful as weather forecasting. The greatest need is for additional observations of earthquake precursors."

ABSTRACTS AND RESUMES

Seismicity and Submarine Volcanic Activity in French Polynesia

Jacques Talandier
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Guy T. Kuster
Laboratoire de Détection et de Géophysique
Commissariat à l'Energie Atomique
Montrouge, France

The implementation of 10 short-period seismic stations in French Polynesia since 1963 allowed the detection of previously unnoticed seismic activity in the central South Pacific (5°-30°S, 125°-160°W). The epicenter location, the depth, and the magnitude of all major events which occurred in this region are tabulated. The Tahiti-Mehetia region, which is the zone of activity closest to the stations, is studied in detail. Swarms of earthquakes are observed at two well-defined sites. Their similarity to typical preeruptive swarms, their location near two seamounts, and the general volcanic context are considered indicative of two active submarine volcanoes. The existence of a 'hot spot' at the southeastern tip of the Society Island chain is suggested.

ANNOUNCEMENTS

Tsunami Meeting, March 23-26, 1977

The Tsunami Committee of the International Union of Geodesy and Geophysics (IUGG) announces a Scientific Meeting on Tsunami Research to be held in Ensenada, Mexico

on March 23-26, 1977 and to be hosted by the Director of the Center for Scientific Investigations and Higher Education of Ensenada. The address of the Center is as follows:

Professor Saul Alvarez Borego
Centro de Investigacion Cientifica y de
Educacion Superior de Ensenada, B.C.
Av. Gastelum No. 898
Ensenada, Baja California, Mexico

Papers on all aspects of tsunamis--physical, theoretical, and sociological--will be considered. Authors are invited to submit, as soon as possible, title and a brief abstract or subject outline to:

Dr. S. L. Soloviev
Chairman, IUGG, Tsunami Committee
Sakhalin Complex Scientific Research Institute
Novoalexandrovsk
Sakhalin 694050, USSR

with a copy to:

Dr. T. S. Murty
Secretary, IUGG, Tsunami Committee
Marine Environment Data Service
Department of Environment
580 Booth St.
Ottawa, Canada

The following particulars have been received concerning the Tsunami meeting in Ensenada:

March 22 - Buses from the San Diego Airport will leave at 1330 and 1830
Buses from the Tijuana Airport will leave at 1430 and 1930

March 24 - Local restaurant banquet

March 25 - Cocktail party

March 27 - Buses for the airport depart at 0800, 1300, and 1800

ITIC has been informed that everything in Ensenada is within walking distance of the local hotel.

Summary of the Session on Tsunamis, in the Topical Conference on Geodetic Measurements in the Ocean, June 28-30, 1976

A topical conference on "Geodetic Measurements in the Ocean" was held at the University of Illinois at URBANA - CHAMPAIGN, during June 28-30, 1976. This conference was sponsored by the following agencies: U.S. Defense Mapping Agency; Marine Technology Society; U.S. National Ocean Survey; U.S. Geological Survey and the department of Civil Engineering of the University of Illinois. A total of seven

sessions were held; upon request from Dr. N. SAXENA, who arranged the conference, Dr. T.S. Murty convened a three hour session on tsunamis, on 29th June.

The following papers were presented:

1. S.L. Soloviev: "Efficiency of the Tsunami Warning System and Possible Improvements"
2. M. Spaeth: "Operational Aspects of the Tsunami Warning Service in the Pacific"
3. G. Pararas-Carayannis: "A New Operational Concept for the International Tsunami Warning System"
4. G.R. Miller: "Real-Time Deep-Ocean Measurements of Tsunamis"
5. T.S. Murty: "Deep-Water Signature of a Tsunami"
6. C.O. Hines: "Proposal for Ionospheric Detection of Tsunamis"

Drs. Miller and Pararas-Carayannis unfortunately could not attend the meeting due to personal reasons, and Mr. Spaeth presented their papers.

The consensus of the discussion was that, for improved warning service, one has to have a better understanding of the deep water signature of a tsunami, than is available at present. Suggestions were made to the possible use of marine geodetic and ionospheric techniques, to supplement oceanographic and seismic observations now used in the warning systems.

Philippine Tsunami Committee Meeting

The Philippine National Tsunami Committee held a special session in Manila, on 6 September, and invited Dr. George Pararas-Carayannis, ITIC Director and Mr. Sydney Wigen, Associate ITIC Director, to attend. The Committee, under the chairmanship of Dr. Catalino Arafles, was particularly interested on the recent tsunami disaster in Mindanao and asked Dr. Pararas-Carayannis to present preliminary findings of the survey of the disaster area. The meeting resulted in a number of positive and constructive recommendations regarding the prediction and moderation of the tsunami disaster in the Philippine Islands, civil preparedness, and the need for a Regional Tsunami Warning System.

Participants in this meeting of the special Interagency Philippine Tsunami Committee included Dr. Catalino Arafles, Chairman, Commodore Jayme Presbitero, Dr. Elvira Tan, Mr. Wellington Minoza, Captain Romeo Valera, Colonel Alexander L. Felix, Lt. Colonel Wilfredo Reotutar, and Dr. Su.

International Conference on the Survival of Humankind: The Philippine Experiment

The International Conference on the "Survival of Humankind: The Philippine Experiment" was held in Manila, Philippines, from September 5-10, 1976. This Conference was under the sponsorship of the Philippine Government with the First Lady of the Philippines, Mrs. Imelda Romualdez-Marcos, as Honorary Conference Chairperson.

At least 120 leading scientists from all over the world and about 400 Philippine experts met in the recently completed International Convention Center, in Manila, to discuss vital issues concerning the survival of humankind, particularly energy, nutrition and health, housing and urban development, education and communication, technology and science transfer and utilization, natural disaster prediction and moderation, and planning management and decision-making.

Dr. Pararas-Carayannis and Mr. Sydney Wigen, who were in the Philippines to survey the effects of the earthquake and tsunami of 17 August, were invited to participate in the Conference. One of the major themes of the conference was on natural disasters, prediction, control and moderation.

The committee on Natural Disaster Prediction Control and Moderation, under the skillful guidance of the administrator, Dr. Roman L. Kintanar of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), accomplished much in recognizing problems and offering solutions on the mitigation of the effects on natural disasters. Following the introductory sessions, the conference participants broke into smaller groups to discuss state-of-the-art on natural disaster, prediction control and moderation. Discussions among the working groups was very fruitful and a number of recommendations were made and officially adopted by the committee on natural disasters regarding typhoons, weather modification, earthquakes and tsunamis. The group included several well-known experts on natural disaster from the Philippines, U.S.A., Thailand, Japan, Canada, Singapore, Indonesia and Malaysia.

Meeting of the Geophysical Society of the Philippines

Dr. George Pararas-Carayannis, Director of ITIC was invited by the Geophysical Society of the Philippines to participate in a special meeting of the Society on 6 September and to give a presentation at the University of Philippines on tsunamis and the Tsunami Warning System in the Pacific.

Tsunami Warning Systems Co-operation Meeting

The second USA-USSR meeting of experts on the improvement and integration of Tsunami Warning Systems took place in Novosibirsk, USSR, from 22-26 September 1976. The heads of delegations were Drs. V. M. Popov and Karl R. Johannessen. Prof. Sergei L. Soloviev co-chaired the meeting with Dr. Johannessen which had participants from the U.S. Geological Survey (Dr. J. Taggart); the NOAA Environmental Research Labs (Dr. G. Miller); the Sakhalin Scientific Complex, Academy of Sciences, USSR; the Computing Center of the Siberian Branch of the Academy of Sciences at Akademgrodok, the world famous scientific community near Novosibirsk.

The agenda of the meeting included items on cooperative tsunami research projects, a discussion of a joint seismic experiment, plans for a new Soviet-American open ocean tsunami measurement expedition, plans for cooperation with the Earthquake Prediction group, the establishment of better communications between the U.S. and the U.S.S.R. in the Tsunami Warning System and arrangements for the exchange of scientists in the future. Plans are for the third meeting to occur in approximately two years.

The results for the meeting are available in the record of discussion which will be in its final form shortly. A more detailed report on the meeting will be available for the next ITIC Newsletter.

HONOLULU OBSERVATORY REPORTS

National Weather Service Announces Plans to Upgrade the Hawaii Regional Tsunami Warning System

It has been recently announced that the National Weather Service has allocated substantial funds to upgrade the seismic and tidal network of the Hawaii Regional Tsunami Warning System.

Specifically, plans call for reinstalling tide gauges at Honuapo and Kailua-Kona on the island of Hawaii and establishing a new tide station on the northeast coast of Maui island. Additional money will be spent on telemetry equipment necessary for transmitting tide and seismic information to Honolulu Observatory. Also, Honolulu Observatory will receive new equipment to replace obsolete and non-operative units.

It is anticipated that work will commence in January 1977, with completion of the upgraded system by December 1977.

Seismic Summary (June 1, 1976 to press-time)

<u>Date and Origin Time (UTC)</u>	<u>Epicenter</u>	<u>Magnitude</u>	<u>Region</u>	<u>Comments</u>
Jun 20 0438 UTC	27.4 N 126.5 E	6.0	Ryukyu Islands	Press Release
Jun 20 2053 UTC	2.8 N 96.2 E	7.2	Sumatra Region	Press Release
Jun 25 1919 UTC	4.4 S 140.2 E	6.9	West Irian, In- donesia	Press Release, three tide sta- tions queried, negative dis- turbance reported
Jun 26 1031 UTC	5.4 N 126.8 E	6.6	Mindanao, Philip- pines Region	Press Release
Jul 11 1655 UTC	7.7 N 77.0 W	6.8	Panama Region	Press Release
Jul 11 2042 UTC	7.6 N 77.4 W	6.9	Panama Region	Press Release
Jul 17 2106 UTC	3.7 S 153.7 E	6.5	New Ireland, Solomon Islands	Press Release
Jul 27 1943 UTC	39.6 N 118.1 E	7.5(HO) 8.2(NEIS)	Northeast China	Press Release

<u>Date and Origin Time (UTC)</u>	<u>Epicenter</u>	<u>Magnitude</u>	<u>Region</u>	<u>Comments</u>
Jul 28 1045 UTC	40.6 N 119.3 E	7.0	Northeast China	Press Release
Aug 2 1055 UTC	18.6 S 169.8 E	6.9	New Hebrides Area	Press Release
Aug 16 1406 UTC	32.7 N 104.8 E	6.5	Southwest China	Press Release
Aug 16 1610 UTC	7.2 N 123.7 E	7.8	Celebes Sea, Philippines	Watch and Watch Cancellation
Aug 17 0420 UTC	7.9 N 123.4 E	6.8	Philippine Islands	Press Release
Sep 30 2334 UTC	29.8 S 177.5 W	6.1	Kermadec Islands	-



Typical village in tsunami
disaster area,
Philippine Islands
August 1976.

Village children greeting ITIC
survey party.

(Photos, S. Wigen, ITIC)



Demolished residences,
Southern Mindanao Island,
Philippines.

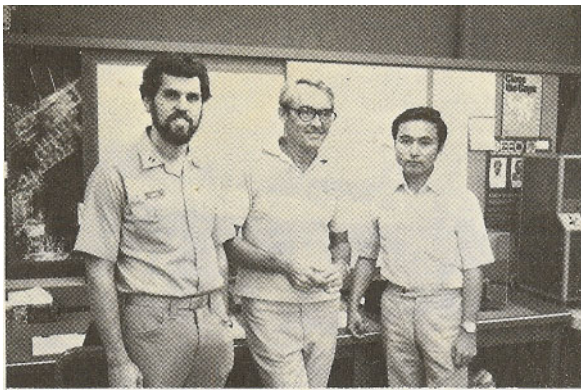


Aerial view of inundated
area, Southern Mindanao
Island, Philippines.

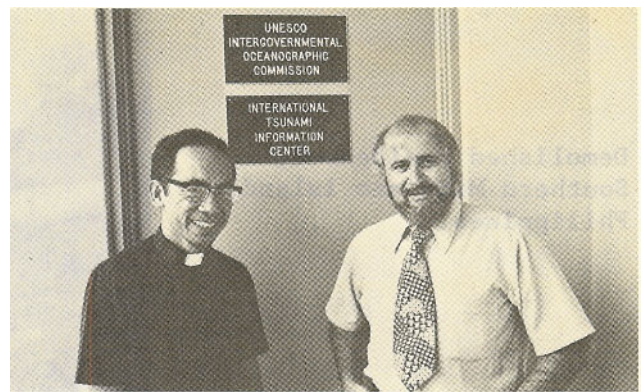
{Photos: by G. Pararas-
Carayannis}

Southern Mindanao Island,
note debris strewn about
by the tsunami.





LT Richard Moore, (left) Chief, Pacific Tide Party and Mr. Masahiro Kishio, (right) Japan Meteorological Agency, Seismology Division, being guided through the Honolulu Observatory by Mr. Joe Zebro, (center) Geophysicist at Honolulu Observatory.



The Reverend Dr. Victor Badillo and Dr. George Pararas-Carayannis at the ITIC office.



Tsunami Damage, Philippine Islands, August 17, 1976. (Note debris carried inland by the wave action)